A GENERAL VERSUS INDIVIDUAL MODEL OF THE SKI JUMPING TECHNIQUE

F. Vaverka[1], M. Janura[1], M. Elfmark[1], M. McPherson[2], R. Puumala[2]

[1] Laboratory of Human Movement Studies, Faculty of Physical Culture, Palacky University, Olomouc
[2] School of Kinesiology, Lakehead University, Thunder Bay

INTRODUCTION

The biomechanical model is the starting point for the application of the research findings into practice. The theoretical studies of the ski jumper's model, reduced on one mass point (e.g. HOCHMUTH, 1959, REMIZOV, 1984) or a limited number of rigid body segments (e.g. HUBBARD et al., 1989, FAYET et al., 1993), have illustrated the physical explanation of the ski jumping problem and defined the physical theory of this sport discipline.

From the point of view of the trainer the stochastic models are very useful for application. The findings are derived from research conducted during natural ski jumping and describe the kinetic or kinematic aspects of the jumper's movement (e.g. KOMI et al., 1974, VAVERKA et al., 1991, SCHWAMEDER et al., 1995, ARNDT et al., 1995). Based on the statistical relationships between the criterion and the measured biomechanical variables, the positive or negative tendencies are defined and the real range of variables can be chosen as a criterion of the ski jumping technique.

Contrary to experiences practice, where the take-off phase is the most important part of the ski jump, the statistical relationships between the biomechanical parameters of the take-off phase and the criterion are very low, mostly statistically nonsignificant ($r=0.1$ - 0.4 , e.g. BAUMANN, 1979, ARNDT et al., 1995). Also the application of factor analysis or stepwise multiple regression analysis have not found closer relationships between the criterion and a group of biomechanical variables (e.g. VAVERKA et al., 1995). The hypothesis of an individual model for the take-off is supported by the multifactor theory of the take-off (VAVERKA, 1987) in which the principle optimisation of the take-off factors and individualisation of the take-off pattern have been defined. Contrary to the take-off phase, the flight phase is a simpler movement situation in which only aerodynamic and gravitation forces are affected during the movement. It can be expected, that only one movement pattern may be defined for the flight phase.

The main goal of this paper is to determine whether one or more models of the take-off and flight phase exist which could serve as the starting point for the application of the research findings into practice.

METHOD

The system for the 2D kinematic analyses of the ski-jump (VAVERKA, 1994, take-off phase) and the Peak Performance Analysis System (flight phase) have been used in this study. The data has been taken from the Intersporttournee Innsbruck event, over two phases, take-off in the period 1993-1995 , $n=155$, and the flight phase in 1995, $n=48$. The set of 11 variables for both the take-off and flight phase served as the input matrix for the statistical analysis (see VAVERKA

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RESULTS

Individual values for the correlation coefficients between the criterion and the take-off parameters in all analysed distances from the take-off edge, are very low and mostly statistical nonsignificant (r = 0.1 - 0.3). Factor analysis and SMRA applied by 5 data matrices of the take-off phase, have indicated a very low level dependence between a set of 11 biomechanical variables and the CLJ. The range of percentage of explained variability of the take-off phase expressed by communality is 7% to 17% (by using of the SMRA R^2 = 0.06 - 0.15). The relationship between individual biomechanical parameters and groups of take-off parameters to the criterion is very low and therefore it can't be defined as a general model of the take-off phase. By contrast, the relationship between the biomechanical parameters and the criterion is much higher in the flight phase. The correlation coefficients are in the range r = 0.1 - 0.81. The factor analysis and stepwise multiple regression analysis have shown a very high level of explained variability of the criterion (83% - 87% by the factor analysis and R^2 = 0.82 - 0.85 by SMRA in the distance 59 m, 68 m, and 75 m of the flight). The variables with high loadings on the criterion factor could be taken as valid parameters and the real range of variables, which is called "model", can be defined.

The individual conception of the take-off could be one of the possible causes of a very low relationship between the criterion and take-off parameters. In Fig.1A, the range of some measured variables by different performance sets of athletes (AG - angle expressing forward-backward position of the centre of gravity, AB - angle between lower leg and ski) are presented in graphical form. The example of the take-off parameter AG shows that the range of interindividual variability of various sets of athletes is almost identical, and from the point of view of linear correlation, the relationship between this parameter and the criterion is very low (r = -0.17, $p < 0.05$). By contrast, the interindividual variability of the flight parameter AB (see Fig. 1B) has confirmed that differences between sets of athletes with various performance levels are very high and the relationship between this parameter and the criterion is statistically significant (r = -0.81). Statistically significant differences between individuals (intraindividual variability) has been confirmed for some take-off parameters, above all for the trunk position and the forward-backward position of the centre of gravity (VAVERKA et al., 1996).

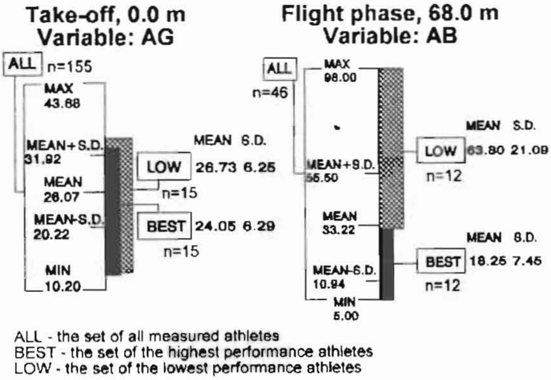

Fig. 1 The range of measured variables by different performance levels of sets of athletes. Intersporttournee Innsbruck, K=109m

In Fig.2 is given in the graphical form an example of the statistical significant differences between five selected individuals on two important parameters of the take-off phase.

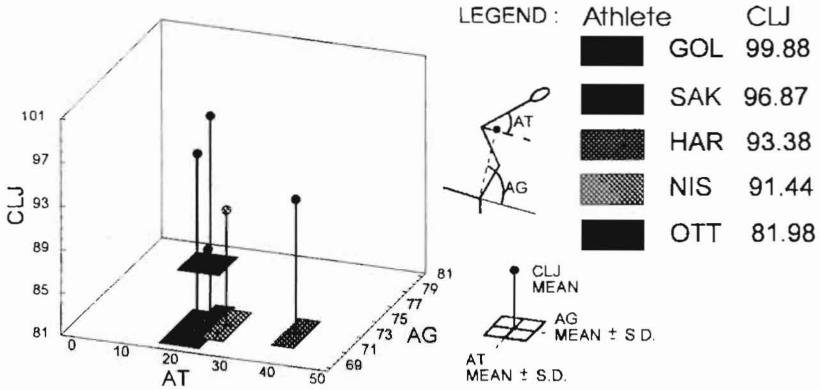

Fig. 2 An example of the intraindividual variability of some selected athletes. Take-off, 0.0 m, variables: AT, AG, CLJ (criterion of the length of jump).

The position of individuals in the graph has confirmed the individual pattern for the realisation of the take-off. It is the reason for a very low statistical dependence between take-off parameters and the criterion by using the linear correlation coefficient methods.

CONCLUSION

Many number of statistical analyses of the take-off and the flight phase of the ski jumping have confirmed different tendencies in the relationship between the biomechanical variables of these two phases to the criterion. In the flight phase the stochastic model expressed by the correlation relationships could be the basis for the formulation of the model characteristics of this ski jumping phase. On the contrary, the take-off phase can't be defined as a general model of the technique based on the linear correlation relationships. The model of the take-off phase is very individual and in practice the trainer must respect this reality. The previous findings show, that it is necessary to extend the group of statistical methods to the solution of the intraindividual variability, The stochastic models based on the analysis of the interindividual variability are not able to fully describe or identify tendencies of individualisation of the sport technique.

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